

Instream Water Quality Evaluation of the Upper Illinois River Basin Using the Index of Biotic Integrity

Thomas P. Simon
U.S. Environmental Protection Agency, Region V
Environmental Sciences Division
Central Regional Laboratory
536 S. Clark Street
Chicago, IL 60605

Abstract

The twelve stations sampled within the Upper Illinois River drainage revealed that the best water quality as indicated by the Index of Biotic Integrity (IBI) was found in the Kankakee, Fox, DuPage, Des Plaines and Chicago River sub-basins, respectively. These areas were correlated with degree of dominant land use, e.g. agriculture and sparse residential areas in the Kankakee and Fox drainages and heavy urban and industrial in the Des Plaines, Chicago, and DuPage drainages. Principal concerns within each of these basins indicate that bank erosion from the lack of a stable riparian zone, combined sewer overflow and street runoff and point sources of pollution contribute greatly to the lower water quality observed.

The stations sampled in each drainage varied in number, however, the overall objective was to provide a quantitative approach to categorizing the biological integrity of the sub-basins on a long-term basis. The IBI was able to rapidly estimate water quality and provide interpretation of water quality without the long-term exercise of measuring water chemistry on a weekly or monthly basis. Yet the amount of similarity based on the two data sets are comparative since the biological fauna assimilates all past and present conditions.

Keywords: IBI, fish, Kankakee River, Des Plaines River, Upper Illinois River Basin, Chicago River and Canals, Fox River

Introduction

The Upper Illinois River has a rich history of biological information dating back to the late 1800's (Mills et al. 1966; Steffeck and Striegl 1988). Information regarding fish distribution and documenting impacts incurred from once through cooling of industries and municipalities has added greatly to the body of data from this region with over 200 published papers and reports. The greatest handicap one has in interpreting this body of information lies in its relevance to the Upper Illinois River as it exists today. Collections on the River have been conducted for a variety of reasons, including but not limited to: species-specific population estimation, general distribution, length-weight ponderal indices, and fisheries management strategy development. The evaluation of water quality within the River has

been one of immense concern, however, the implications of such varied collection techniques and study objectives has practically made the historic data base uninterpretable.

As part of the National Water Quality Assessments (NAWQA) Pilot Survey the Environmental Science Division's Central Regional Laboratory (CRL) of the Environmental Protection Agency (USEPA), Region V surveyed twelve stations in the basin to evaluate instream biological quality of the Upper Illinois River. Karr's index of biotic integrity (1986) was used to evaluate water quality based on fish communities.

Fish sampling was conducted at twelve stations within the Upper Illinois River basin which has the mainstem initiate at the junction of the Des Plaines and Kankakee Rivers, Will

County, Illinois and for this study terminated just below the junction with the Fox River at Ottawa, Illinois.

Sampling in the Upper Illinois River basin began during late July 1989 and was completed by late August. Water conditions were stable and close to normal conditions following drought conditions observed during summer 1988.

Study Area

The Upper Illinois River is considered a seventh order tributary in the vicinity of Ottawa, Illinois (IEPA 1988). The River is comprised of five sub-basins comprising the Kankakee, Chicago, Des Plaines, DuPage, and Fox Rivers. The general flow of the River is from northeast to southwest, with the most northerly sub-basin originating in Waukesha County, Wisconsin (Fox River) and the most easterly sub-basin in St. Joseph County, Indiana (Kankakee River). The River is primarily contained within the Central Cornbelt Plains ecoregion with a minor portion of its headwaters occurring in the Southeastern Wisconsin Till Plains ecoregion (Omernik 1987). The dominant land use in both ecoregions is cropland, however, soil constituents and the urban area of Chicago are the major differences. Low to moderate flows occur within the Rivers.

The study area borders the shores of Lake Michigan and is a primary drainage of the upper Mississippi River. The River has a series of navigation impoundments on the mainstem which has made the River more homogeneous, turning it into a series of pools. Each of the sub-basins has a series of low-head dams or flood control dams. The Kankakee River has a single dam on its entire length, and the entire stretch within Indiana has been ditched. The Chicago River, which previously was considered a Lake Michigan drainage tributary, was included in the current study because

of its connection with the Upper Illinois River through the Sanitary and Ship Canal.

Station Locations

A total of twelve stations were sampled from July 26 to August 24, 1989 (Fig. 1). All stations occur in the State of Illinois unless otherwise noted. The furthest station downstream in the Upper Illinois River basin was the Illinois River at Marsailles (station 1), LaSalle Co., downstream of the dam from Central Illinois Power (R.M. 246.4) to Delbridge Creek (R.M. 245.5), T 33N R 4E S 15/16.

The first sub-basin was the Fox River which included three stations, one mainstem and two tributaries. Station 2, was the Fox River near the Rt. 62 bridge, Algonquin, Algonquin Township, downstream of the dam influence at a crossover walk bridge but upstream of the Algonquin STP (T 43N R 8E S 30). Station 3 was at Indian Creek, LaSalle Co, 11 mi N Ottawa, Freedom Township, at E 1553 and E 16th Street bridge intersection (T 35N R 3E S 1/2). Station 4 was at Honey Creek, Walworth Co., WI, Himelbaugh Road bridge, 7 mi N Burlington (T 4N R 18E S 25).

The second sub-basin was the DuPage River which included two stations. Station 5 was the DuPage River, Will Co., 1 mi N Shorewood, downstream of Black Road bridge at Hammel Woods DuPage River access (T 35N R 9E S 10). Station 6, was the East Branch of the DuPage River, Will Co., off Royce Road, 2-1/2 mi NW Bolingbrook, 1/2 mi E of Naperville Road intersection, (T 37N R 10E S 5/8).

Sub-basin 3 was the Des Plaines River which included two mainstem stations and a tributary station. Station 7, Des Plaines River at Brandon Road Lock and Dam, Will Co., was 3 mi S Joliet and sampled in a backwater area on the east side of the Navigation channel, (T 5N R 10E S 20). Station 8, Des Plaines River at Riverside, Cook Co., was accessed at a Cook County Forest

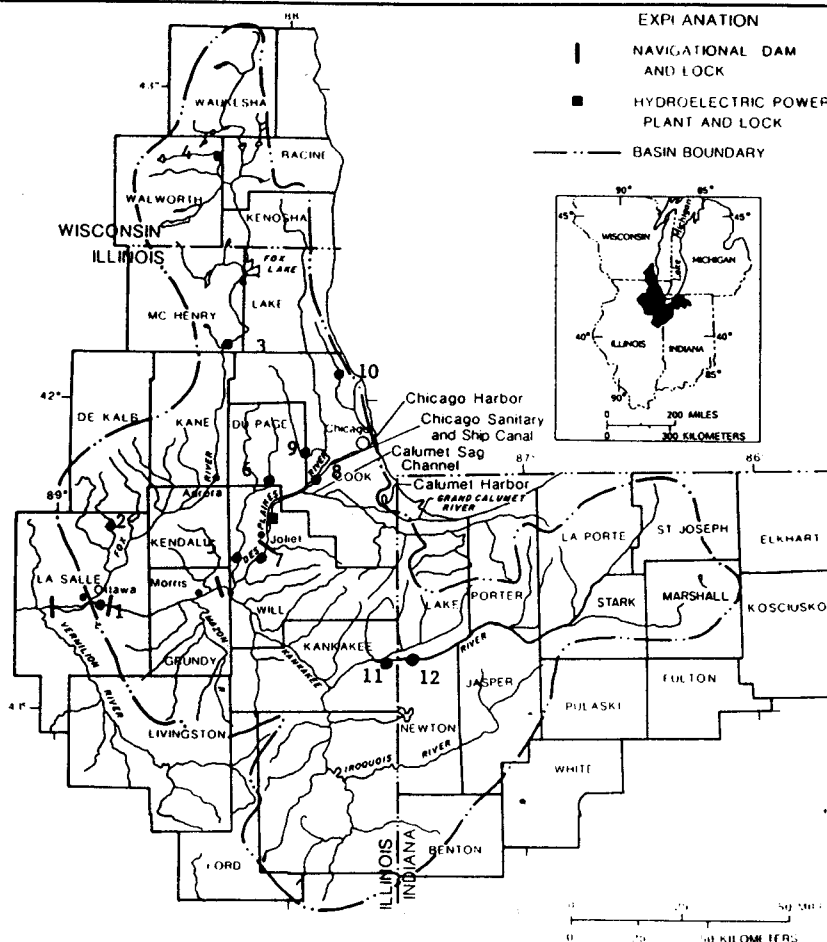


Fig. 1. Station locations for fish collected in the Upper Illinois River basin during 1989.

Preserve off 40th Street (T 39N R 12E S 36). Station 8 was downstream of the confluence of Salt Creek. Station 9, Salt Creek, Cook Co., at Beamis Woods footpath 1/2 mi N Western Springs off Wolf Road and Ogden Road (Rt. 34) (T 39N R 11E S 31).

Sub-basin 4 included the Chicago River basin and the canal system. A single station was sampled in this basin. Station 10, North Branch Chicago River, Cook Co., at Touhy Avenue bridge, 1.5 mi S Niles (T 42N R 12E S 15).

Sub-basin 5 was the Kankakee River basin which included two mainstem locations. Station 11, was the Kankakee River at Momence, Kankakee Co., off E 1050N, 1 mi from Rt. 114 bridge, T 31N R 13E, S 22/23. Station 12, Kankakee River, Newton Co., Indiana,

In Rt. 55 bridge, 1 mi S Shelby, Eagle Creek Township, T 32N R 8W S 33/34.

Materials and Methods

Fish Sampling

The sampling protocols for fish follows that documented in the USEPA, Environmental Science Division's, Central Regional Laboratories Standard Operating Procedure for Rapid Assessment using fish (1988).

The following collection techniques were applied to obtain a representative sample from each of twelve stations within the Upper Illinois River basin. All habitats that were present were sampled including riffle, pool, and run. No samples were taken in the vicinity of bridges, or in the mouths of tributaries entering large rivers, lakes or reservoirs since they tend to be more similar to larger-

order habitats than the one under consideration (Fausch et al. 1984).

Seines were considered by Karr et al. (1986) the best collection tool for obtaining an unbiased sample in small streams. As stream complexity increased a 50 ft. bag seine with 1/8 in mesh was utilized for collection and a boat mounted pulsed DC electroshocker was selectively included at appropriate sites. The seine was able to get an excellent representation of the species present, since low water levels allowed easy access for most portions of the Rivers. Likewise, adult species which only use the stream in a transitory manner would be excluded from this analysis (e.g. adult salmonids, eels). Young-of-the-year species less than 20 mm total length were excluded following the recommendations of Angermeier and Karr (1986). Distances between 100 to 500 m were sampled at each site and included similar levels of effort (usually 1 hr of intensive sampling per 100 m) within all available habitats.

Each sampling period consisted of a single site visit under normal to moderate flow conditions. During field collection, all larger specimens were identified to species, smaller specimens of minnows and darters were preserved in 10% formalin, and returned to the laboratory. At the completion of the study, voucher specimens were deposited into the fish collection repository at the Field Museum of Natural History.

The ambient environmental data was evaluated using the Index of Biotic Integrity (IBI; Karr et al. 1986). The IBI relies on multiparameters based on community concepts, to evaluate a complex system. It incorporates professional judgement in a systematic and sound manner, but sets quantitative criteria that enables determination of what is poor and excellent based on species richness and composition, trophic constituents, and fish abundance and condition. The twelve

IBI metrics reflect insights from several perspectives and cumulatively are responsive to changes of relatively small magnitude, as well as broad ranges of environmental degradation (Table 1).

Since the metrics are differentially sensitive to various perturbations (e.g. siltation or toxic chemicals), as well as to various levels within the range of integrity, conditions at a site can be determined with considerable accuracy. The interpretation of IBI numerical scoring is provided in six narrative categories that have been tested in Region V (Karr 1981; Table 2).

Several of the metrics are drainage size dependent and require selection of numerical scores. The ecoregion approach developed by USEPA-Corvallis, OR was utilized to compare least impacted zones within the region (Omernik 1986). Extensive work within the Central Corn Belt Plain ecoregion by Illinois EPA (1988) and documentation in Karr et al. (1986), were used to determine "excellent" or control conditions for scoring the metrics based on stream sizes equivalent to the various sub-basins in the Upper Illinois River basin (Table 3).

Habitat Evaluation

A habitat quality evaluation assessment was completed in conjunction with fish collection. The QHEI, quality habitat evaluation index, developed by Ohio EPA (1986) provides numerical assignments for six criteria to assess riffles and pools. The criteria were modified to include only five of Ohio's criteria and were adjusted to reflect the same equivalent total score. Scoring was based on 100 total points and incorporates substrate quality, instream cover, channel morphology, riparian zone and bank erosion, and pool and riffle quality based on drainage area.

For station comparisons of the fish samples to be considered valid, the

TABLE 1. Scoring criteria for 12 IBI metrics for low to moderate gradient streams within the Northeastern Region of Illinois for the Upper Illinois River basin (Karr et al. 1986).

Metrics	Scores		
	1	3	5
1. Number of total species	Stream size dependent		
2. Number of darter species	Stream size dependent		
3. Number of sucker species	Stream size dependent		
4. Number of sunfish species (excluding <i>Micropterus</i>)	Stream size dependent		
5. Number of intolerant species	Stream size dependent		
6. Proportion of individuals as Green Sunfish	>20%	5-20%	< 5%
7. Proportion of individuals as omnivores	>45%	20-45%	<20%
8. Proportion of individuals as insectivorous minnows and darters	<20%	20-45%	>45%
9. Proportion of individuals as piscivores	<1%	1-5%	>5%
10. Catch rate (number/100 m)	Varies with gear and stream size		
11. Proportion of individuals with poor condition or disease	>5%	>2-5%	<2%
12. Proportion of individuals as hybrids	>5%	1-5%	<1%

stations must be capable of supporting the same type of communities. A stream section habitat evaluation was used to determine if all sample sites had similar habitat types for comparisons.

In order for a station to be comparable habitat scores from the QHEI had to be within 90% to be comparable and at least 75% to be supportive (Plafkin et al. 1989).

Results

Quality Habitat Evaluation Index

Flow, bank erosion, and warmer water temperatures varied the habitat within

the Upper Illinois River basin between the various sub-basins (Table 4). Habitat criteria was developed for each site based on the quality of the site for promoting biological diversity. The highest QHEI score during the current study was 89.3. Comparing all other scores to this value resulted in seven stations being equal in available habitat, two stations being comparable, and three stations not meeting the 75% criteria. The station with the best overall habitat score was Honey Creek (Fox River sub-basin) station 4. The Upper Illinois River at Marsailles

Upper Illinois River Water Quality

Table 2. Biotic integrity classes used in assessing fish communities along with general descriptions of their attributes (Karr et al. 1986).

Class	Attributes	IBI Range
Excellent	Comparable to the best situations without influence of man; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with full array of age and sex classes; balanced trophic structures.	58-60
Good	Species richness somewhat below expectation, especially due to loss of most intolerant forms; some species with less than optimal abundances or size distribution; trophic structure shows some sign of stress.	48-52
Fair	Signs of additional deterioration include fewer intolerant forms, more skewed trophic structure (e.g., increasing frequency of omnivores); older age classes of top predators may be rare.	39-44
Poor	Dominated by omnivores, pollution-tolerant forms, and habitat generalists; few top omnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.	28-35
Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, and other anomalies regular.	12-22
No Fish	Repetitive sampling fails to turn up any fish.	

Table 3. Metric scores for Illinois Northeast region surface waters of various stream orders for calculating the Index of Biotic Integrity (criteria shown is for the score of 3, values greater than that listed receive a 5 and lower a 1; IEPA 1988).

Metric	Stream Order					
	2	3	4	5	6	7
1. Total number of species	6-10	7-12	8-14	9-16	10-18	11-20
2. Number of Darter species	2	2-3	2-3	3-4	3-5	3-5
3. Number of Sunfish species	1	2	2-3	2-3	3-4	3-4
4. Number of Sucker species	2	2-3	2-3	3-4	3-5	3-5
5. Number of Intolerant species	2-3	2-3	3-4	3-5	3-5	4-6

(station 1), Fox River at Algonquin (station 2), DuPage River at Shorewood (station 5), East Branch DuPage River near Bolingbrook (station 6), the Des Plaines River at Brandon Road (station 7), and Des Plaines River at Riverside (station 8) were habitat equal, while Indian Creek (station 3), and Kankakee River at Momence (station 11) were habitat compatible. Habitat limited were Salt Creek at Beamis Woods (station 9), North Branch Chicago River (station 10), and Kankakee River at Shelby, IN (station 12). The primary causes of habitat degradation was channelization, siltation and embeddedness.

Fish - Index of Biotic Integrity

Illinois River-Mainstem : River conditions at Marsailles indicated "fair to poor" conditions from the upstream headwater drainage (Table 5). Sampling techniques used at this station consisted of 50 ft bag-seining, and electrofishing for 500 m of river reach. Habitat sampled included 70% riffle, 20% run and 10% pool.

Poor metric scores contributing to reduced station scoring included number of darter, sunfish, and sucker species, number of intolerant species, and number of individuals in the sample. Excellent scores were achieved for proportion of green sunfish, proportion of omnivores and carnivores, number of hybrids, and disease factor.

Dominant taxa within the site included emerald shiner (77.96%), gizzard shad (9.82%), and freshwater drum (3.61%). Intolerant taxa included three taxa. A stable level of carnivores were found in the drainage including smallmouth bass, flathead catfish, channel catfish, and white bass. Bullhead minnow, flathead catfish and white bass were collected exclusively at this station. Larval specimens of emerald shiner and gizzard shad were abundant along the margins of the River.

Fox River Basin: The Fox River basin obtained the highest IBI score among

all Upper Illinois River sampling with a score of 52 at Indian Creek. A rating of "good" at Indian Creek was similar to the high score in the Kankakee basin. The Fox River at Algonquin rated "fair" and Honey Creek a "poor". Sample distances collected at the Fox River at Algonquin, Indian Creek and Honey Creek were 250 m, 100 m, and 150 m, respectively. Habitat sampled in the Fox River consisted of 70% run, and 15% each of pool and riffle. The primary collection technique was a 50 ft bag seine and a 10 ft common minnow seine. Indian Creek sampling consisted of common minnow seining within habitat composed of 30% each of pool and riffle, and 40% run. Honey Creek was likewise seined using a 10 ft common minnow seine within habitat composed of 15% pool, 40% riffle and 45% run.

The mainstem Fox River was classified "fair" due to low scores for number of darter, sucker, and intolerant species; and proportion of carnivores (Table 6). Sampling downstream of the walk bridge but upstream of the Algonquin STP resulted in high scores for total number of taxa, number of sunfish species, proportion of green sunfish, proportion of omnivores and insectivores, number of individuals in the sample, lack of hybrids, and disease. Indian Creek scored very high in most categories except number of sunfish species, while Honey Creek scored poorly in number of darter and sunfish taxa, proportion of carnivores, number of individuals and diseased individuals. A high proportion of individuals had black spot indicating environmental stress at Honey Creek.

Taxa unique to the Fox River basin included yellow bass at Fox River at Algonquin, and rainbow and fantail darters at Indian Creek. The downstream pool and riffle habitat had several intolerant taxa including two taxa at the Fox River proper, eight taxa at Indian Creek, and two taxa at Honey Creek. The most dominant taxa at

Upper Illinois River Water Quality

Table 4. Quality Habitat Evaluation Index scores for twelve stations sampled in the Upper Illinois River basin, during 1989.

Character	Illinois River	Fox River	Indian Creek	Honey Creek	DuPage River	E. Branch DuPage River
<u>predominate substrate</u>	boulder/sand	sand/cobble	sand/gravel	sand/cobble/gravel	sand	sand/gravel
<u>Silt covered Area affected</u>	none	none	none	none	none	none
<u>Instream Cover Relative %</u>	extensive	sparse	sparse	sparse-moderate	sparse	sparse
<u>Channel Morphology</u>						
sinuosity	none	moderate	high	high	moderate	moderate
development	good	fair	fair	good	fair	fair
channelization	recovered	none	none	none	none	none
stability	moderate	high	low	high	moderate	moderate
<u>Riparian Zone</u>						
Zone width	moderate	narrow	very narrow	wide	wide-extensive	extensive-narrow
Quality	forest	residential	open pasture	forest	park/forest	forest/park
Bank erosion	little	little	moderate	little	moderate	little
OHEI score	83.1	89.0	74.3	89.3	88.1	87.0

Table 4. (continued)

Character	Des Plaines Brandon	Des Plaines Riverside	Salt Creek	N. Branch Chicago R.	Kankakee Momence	Kankakee Shelby
<u>predominate substrate</u>	muck/bedrock	sand/bedrock	sand	sand	sand/gravel	sand
<u>Silt covered Area affected</u>	pools	none	none	none	none	none
<u>Instream Cover Relative %</u>	moderate	moderate	sparse	sparse-moderate	moderate	sparse
<u>Channel Morphology</u>						
sinuosity	low	moderate	low	none	low	low
development	good	good	fair	good	fair	fair
channelization	none	recovered	recovered	recovered	none	recovered
stability	low	low	moderate	moderate	high	moderate
<u>Riparian Zone</u>						
Zone width	narrow	wide	moderate	moderate/narrow	very narrow	narrow
Quality	forest/old field	forest	forest	forest	residential	residential
Bank erosion	moderate	heavy	little	little	none	moderate
OHEI score	81.5	83.7	59.2	57.6	74.5	61.7

Table 5. Fish collected, length range, number and relative percent composition from the Illinois River mainstem collected during July and August, 1989.

Species	Illinois River at Marsailles		
	N	%	Range mm
Gizzard shad	49	9.8	100-128
Quillback	1	0.2	300
Carp	2	0.4	345-688
Emerald shiner	389	77.9	59-110
Spottail shiner	1	0.2	100
Sand shiner	2	0.4	52-54
Spotfin shiner	10	2.0	36-51
Golden shiner	1	0.2	100
Bluntnose minnow	4	0.8	45-52
Bullhead minnow	1	0.2	38
Flathead catfish	1	0.2	650
Channel catfish	4	0.8	350-475
White bass	5	1.0	200-300
Bluegill	6	1.2	68-250
Smallmouth bass	5	1.0	300-385
Freshwater drum	18	3.6	375-500
IBI score	36		

Algonquin were spotfin shiner (63.1%), brook silverside (23.94%), and orangespotted sunfish (4.87%). Taxa dominant at Indian Creek included spotfin shiner (34.14%), sand shiner (21.72%), and common shiner (10.0%), while at Honey Creek dominant taxa included sand shiner (39.13%), spotfin shiner (31.3%), and golden shiner (18.26%). Unique taxa collected in the Fox River included yellow bass.

Larval fish collected or observed on the Fox River at Algonquin downstream of the walk bridge along run habitat included cyprinids and centrarchids. Downstream along the pool margins green sunfish and brook silverside were collected. Few larval fish were collected from Indian Creek with those collected being sand shiners. No larval fishes were collected from Honey Creek.

DuPage River Basin: Two stations were sampled in the DuPage River basin. The

furthest downstream station, DuPage River proper at Shorewood (station 5), was seined for 200 m of stream reach and included 45% run, 45% riffle and 10% pool habitat. The East Branch of the DuPage River (station 6), was seined using a 10 ft common minnow seine for 100 m. The habitat sampled included 40% each of run and riffle, and 20% pool. A disjunct collection was obtained at this location with the majority of sampling being conducted in the run and riffle habitat along the margins of the park. Additional sampling was conducted upstream of the primary site, in the tree line around the bend in the River.

The mainstem DuPage River scored an IBI rating of "fair to good", while the East Branch station rated "poor" (Table 7). Contributions to reduced metric scores at Shorewood were low numbers of darter species (metric 2) and catch per unit effort (metric 10). High scores were observed for total number of species, proportion of green sunfish, proportion of omnivores, insectivores, and carnivores, lack of hybrids and diseased individuals. The East Branch of the DuPage River had reduced scores because of the lack of benthic and intolerant taxa (metrics 2, 4, and 5), reduced catch per unit effort (metric 10), and high proportion of diseased individuals (mostly black spot). High scores were observed for proportion of green sunfish, proportion of insectivorous cyprinids, and no hybrids.

Salt Creek. At Brandon Road, 60% riffle, 25% pool, and 15% run habitat was sampled for 300 m of stream reach. Riverside sampling consisted of 55% riffle, 25% run and 20% pool habitat being sampled for 400 m. This location consisted of a disjunct collection with 300 m sampled in the primary location (the long run and riffle) and 100 m sampled upstream in the River bend. Salt Creek was sampled for 100 m with 100% of the habitat consisting of run habitat.

Upper Illinois River Water Quality

Table 6. Fish collected, length range (range measured in mm), number and relative percent composition from the Fox River sub-basin of the Upper Illinois River collected during July and August, 1989.

Species	Location								
	Fox River at Algonquin			Indian Creek			Honey Creek		
	N	%	Range	N	%	Range	N	%	Range
Northern pike	1	0.1	875						
Carp	2	0.1	300-575						
Common stoneroller				2	0.7	49-92			
Emerald shiner	1	0.1	69						
Rosyface shiner				10	3.5	40-67			
River shiner				1	0.3	91			
Bigmouth shiner							21	18.3	32-71
Sand shiner	1	0.1	30	63	21.7	30-70	45	39.1	30-66
Mimic shiner				21	7.3	52-65			
Spottail shiner	1	0.1	38						
Spotfin shiner	1310	63.1	30-84	99	34.1	28-80	36	31.3	45-74
Common shiner				29	10.0	94-104			
Golden shiner	32	1.5	48-144				1	0.9	65
Bluntnose minnow	1	0.1	32	10	3.5	35-70	8	7.0	24-65
Fathead minnow	12	0.6	28-60						
Suckermouth minnow				2	0.7	49-55			
Hornyhead chub				2	0.7	40-100			
Creek chub				1	0.3	66			
White sucker							1	0.9	61
Quillback	10	0.5	59-95	2	0.7	60-66			
Smallmouth buffalo	9	0.4	69-114						
Northern hogsucker				4	1.4	55-65			
Silver redhorse							1	0.9	54
Brook silverside	497	23.9	21-77	3	1.0	44-49			
Yellow bass	7	0.3	64-275						
Black bullhead	5	0.3	200-275						
Largemouth bass	1	0.1	44						
Smallmouth bass				26	9.0	45-180			
Bluegill	71	3.4	20-83						
Green sunfish	3	0.1	22-27	7	2.4	30-114			
Pumpkinseed	1	0.1	100						
Orangespotted sunfish	101	4.9	22-82						
White crappie	6	0.3	50-72						
Black crappie	4	0.2	51-70						
Johnny darter				1	0.3	49	2	1.7	44-61
Rainbow darter				2	0.7	35-43			
Fantail darter				1	0.3	25			
Banded darter				4	1.4	47-56			
IBI score	44			52			32		

Table 7. Fish collected, length range (range measured in mm), number and relative percent composition from the DuPage River sub-basin of the Upper Illinois River collected during July and August, 1989.

Species	Location					
	DuPage River at Shorewood			East Branch DuPage River		
	N	%	Range	N	%	Range
Gizzard shad	3	1.1	69-95	19	25.3	47-85
Carp	1	0.4	350			
Common stoneroller	1	0.4	50	4	5.3	51-119
Bigmouth shiner				6	8.0	58-64
Sand shiner	12	4.5	25-69	6	8.0	57-66
Spotfin shiner	184	68.7	40-58	29	38.7	49-94
Common shiner	2	0.8	46-55	1	1.3	102
Golden shiner	1	0.4	55			
Bluntnose minnow	19	7.1	25-69	3	4.0	56-73
Creek chub				1	1.3	134
Quillback	2	0.8	250-325			
Smallmouth buffalo	1	0.4	195			
Blackstripe topminnow	3	1.1	30-67			
Largemouth bass	3	1.1	55-138	1	1.3	82
Smallmouth bass	12	4.5	45-325			
Bluegill				4	5.3	53-81
Green sunfish	1	0.4	95	1	1.3	127
Longear sunfish	12	4.5	64-89			
Orangespotted sunfish	3	1.1	38-66			
IBI score	46			32		

Dominant taxa at the DuPage River at Shorewood included spotfin shiner (68.66%), bluntnose minnow (7.09%), and equal dominance of sand shiner, smallmouth bass, and longear sunfish (4.48%). Dominant taxa on the East Branch included spotfin shiner (38.67%), Gizzard shad (25.33%), and equal numbers of sand and bigmouth shiners (8.0%). Four intolerant taxa were collected at Shorewood and one on the East Branch.

Few larval taxa were observed in the DuPage basin. Spotfin shiner larvae were the only taxa observed and only at the DuPage River at Shorewood.

Des Plaines River Basin: Three stations were sampled in the Des Plaines River basin, including the Des Plaines River at Brandon Road (station 7), Des Plaines River at Riverside

(station 8), and Salt Creek (station 9). Seining and electrofishing techniques were used at Brandon Road, while only seining was conducted at Des Plaines River at Riverside and IBI scores at Brandon Road and Riverside rated "poor" with equivalent scores of 34 (Table 8). At Salt Creek a score of 30 rated the site "poor" (Table 8). Reduced metric scores at Brandon Road were observed for five metrics with low scores for number of darter and sucker species, number of intolerant taxa, proportion of omnivores, and reduced catch per unit effort. Low scores at Riverside were likewise a result of five metrics, including numbers of darters, suckers and intolerant species, proportion of carnivores, and reduced catch per unit effort. Six metrics scored poorly for Salt Creek with low scores for total number of species, number of darter,

sucker, and intolerant taxa, proportion of carnivores, and catch per unit effort.

Dominant taxa at Brandon Road include bluntnose minnow (39.74%), emerald shiner (25.64%), and carp (10.26%). At Riverside dominant taxa included sand shiners (44.16%), bluntnose minnow (19.05%) and spotfin shiner (14.72%). Salt Creek was dominated by spotfin shiner (50.0%), bluntnose minnow (28.57%), and green sunfish (10.71%). Intolerant taxa included two taxa at Brandon Road, and a single taxa at Riverside and Salt Creek. Unique taxa collected in the Des Plaines River included mosquitofish at Riverside.

Many of the fish collected during the collections in the Des Plaines River were young of the year specimens. An abundance of tolerant taxa, i.e. green sunfish, bluntnose minnow, and fathead minnow, indicated degraded conditions for most of this basin from the urban and industrial areas of Chicago.

Chicago River and Canal Sub-Basin:

A single station was sampled in the Chicago River basin. The North Branch of the Chicago River at Touhy Avenue (station 10) was sampled for 100 m and consisted of entirely run habitat.

This station, although rigorously sampled, did not produce any fish. Several crayfish and a large snapping turtle were collected and released. This station scored the poorest of all 1989 Upper Illinois River stations with a score of zero (no fish).

Kankakee River Basin: Two stations were sampled in the Kankakee River basin, including the Kankakee River at Momence (station 11) and Kankakee River at Shelby, Indiana (station 12). Sampling at Momence consisted entirely of seining for 300 m and included 50% each of run and riffle habitat. At Shelby, channelization of the Kankakee River resulted in both seining and electrofishing methods needing to be conducted. Over 500 m of

reach was sampled by electrofishing and 50 m was sampled seining. The habitat within this reach consisted of 65% run and 35% pool.

The Kankakee River basin consistently scored the highest of all sub-basins collected during 1989. A rating of "good" was observed at Momence with a score of 52, and a rating of "fair" at Shelby with a score of 44 (Table 9). The only low score at Momence was for catch per unit effort, while at Shelby low scores were given for number of darter species, proportion of carnivores, and catch per unit effort.

Dominant taxa at Momence included spotfin shiner (41.04%), sand shiner (18.66%), and orangespotted sunfish (13.43%). At Shelby dominant taxa included spotfin shiner (87.45%), sand shiner (4.73%), and carp (2.47%). The number of intolerant taxa at Momence was seven taxa and five taxa at Shelby. At Momence unique taxa collected included spotted sucker, blackside darter, and mimic shiner.

Discussion

Water quality characterization of twelve stations within the Upper Illinois River basin provided expected results based on known water chemistry, areas of dominant land use, habitat and known point source dischargers (Fig. 2).

Increased biological integrity, as it relates to water quality, was observed from an upstream to downstream direction for the all of the various sub-basins. Reasons for these trends in index of biotic integrity rating depended on a variety of factors. In the Fox River sub-basin, at two similar sized streams, water quality was considered "good" at Indian Creek and "poor" at Honey Creek. Habitat quality was the reverse, with Honey Creek consisting of superior riparian zone and habitat cycles, while Indian Creek was in the center of a cow pasture. The Fox River proper was sampled only at a single site and was

Table 8. Fish collected, length range (range measured in mm), number and relative percent composition from the Des Plaines River sub-basin Upper Illinois River collected during July and August, 1989.

Species	Location								
	Des Plaines River Brandon Road			Des Plaines River Riverside			Salt Creek		
	N	%	Range	N	%	Range	N	%	Range
Northern pike	1	1.3	250						
Grass pickerel	1	1.3	134						
Gizzard shad				22	9.5	59-105			
Carp	8	10.3	300-500	3	1.3	372-750			
Goldfish	1	1.3	35						
Emerald shiner	20	25.6	53-76						
Spottail shiner				4	1.7	41-60			
Bigmouth shiner				3	1.3	39-46			
Sand shiner				102	44.2	22-65	1	3.6	33
Spotfin shiner	1	1.3	42	34	14.7	22-65	14	50.0	35-58
Bluntnose minnow	31	39.7	23-38	44	19.1	21-60	8	28.6	25-43
Fathead minnow				12	5.2	22-32	1	3.6	24
Smallmouth buffalo	1	1.3	300						
Blackstripe topminnow	5	6.4	65-72						
Mosquitofish				3	1.3	26-37			
Tadpole madtom	1	1.3	34						
Largemouth bass									
Bluegill	6	7.7	35-61	3	1.3	22-66	1	3.6	22
Green sunfish				1	0.4	84	3	10.7	65-125
White crappie	1	1.3	115						
Black crappie	1	1.3	75						
IBI score	34			34			30		

intermediate in quality between the upper and lower tributary segments. A rating of "fair" was scored because of a lack of benthic species (e.g. darters and suckers), however, a number of catfish were collected including various bullheads. Reasons for a decline at Algonquin were due to the uniformity of habitat (e.g. mostly run), and the lack of riparian buffer zone along the mostly residential shoreline. Input of nutrients from septic systems and runoff of fertilizers have probably contributed to degradation along this stretch of the River. Upstream of the site was a dam and downstream was the Algonquin STP. Both of these may act as barriers to recolonization of fish species from

upstream and downstream refugia. The lack of darters was surprising since suitable riffle habitat was present at this site.

The DuPage River sub-basin, indicated that the East Branch of the River was "poor" and probably a result of upstream perturbations. The East Branch has undergone a series of building projects in many of the towns which line the River upstream. The lack of a substantial fish population at this station is indicative of areas with organic enrichment. The preponderance of green sunfish and the increase of black spot disease affecting individuals of the insectivorous trophic guild (e.g.

Upper Illinois River Water Quality

Table 9. Fish collected, length range (range measured in mm), number and relative percent composition from the Kankakee River sub-basin of the Upper Illinois River collected during July and August, 1989.

Species	Location					
	Kankakee River at Mokence			Kankakee River at Shelby		
	N	%	Range	N	%	Range
Grass pickerel	2	0.8	119-192			
Carp				12	2.5	432-628
Common stoneroller				1	0.2	51
Rosyface shiner				1	0.2	68
Sand shiner	50	18.7	37-68	23	4.7	40-65
Mimic shiner	4	1.5	52-76			
Bigmouth shiner				4	0.8	36-65
Spotfin shiner	110	41.0	36-70	425	87.5	35-85
Common shiner	20	7.5	94-176	3	0.6	40-52
Bluntnose minnow	2	0.8	54-63			
Creek chub				2	0.4	42-44
Hornyhead chub	1	0.4	82			
Northern hogsucker	1	0.4	212	4	0.8	125-250
Shorthead redhorse	1	0.4	143	3	0.6	152-314
Spotted sucker	5	1.9	130-167			
Brook silverside	7	2.6	33-49	3	0.6	32-37
Blackstripe topminnow	3	1.1	55-59			
Rock bass	12	4.5	70-93	1	0.2	151
Largemouth bass				2	0.4	115-135
Bluegill	3	1.1	80-131			
Green sunfish				1	0.2	91
Longear sunfish	5	1.9	78-101			
Orangespotted sunfish	36	13.4	46-78			
Black crappie	1	0.4	115	1	0.2	103
Johnny darter	1	0.4	39			
Banded darter	3	1.1	45-50			
Blackside darter	1	0.4	86			
IBI score	52			44		

spotfin shiner) are usually a result of fertilizer runoff and muck or soft substrates. The lack of a riparian zone probably has contributed greatly to this problem. The downstream location at Shorewood, on the mainstem DuPage River had an IBI rating of "fair to good". This particular station had a high proportion of smallmouth bass and insectivorous cyprinids which usually indicate increased water quality. A variety of sunfishes and other species typical of good pool habitat were present, as well as, specimens of herbivores and

other trophic guilds. This particular station has potential for increased water quality scores in future sampling events.

The Des Plaines River sub-basin was rated the second poorest of the Upper Illinois River sub-basins. The River typically scored "poor" with downstream areas scoring higher than upstream locations. Brandon Road Lock and Dam was a surprise since the majority of the backwater habitat possessed an abundance of aquatic macrophytes and soft muck sediments. A

high proportion of intolerant taxa were present including a number of game species, e.g. black and white crappie, northern pike, and bluegill. Tadpole madtom and smallmouth buffalo, both benthic species indicated that conditions were improving over historic conditions at this location. A nice firm riffle over a bedrock substrate may provide adequate habitat for Moxostoma species and other larger river species. Although redhorses were not collected during the present collection, further sampling will probably indicate their presence. The site at Riverside was equally impressive with a nice riffle/run along the margin of the Cook County Forest Preserve. A high amount of erosion does affect this site, since it too possessed few benthic species. The presence of both bigmouth and sand shiners, and a high proportion of insectivorous cyprinids indicates that it has potential to improve in water quality. Salt Creek the furthest upstream location sampled in the Des Plaines sub-basin had limited habitat diversity. Species collected at the station were expected for the site, due to the lack of true pool and the limited, basically non-existent, riffle habitat. Species using these types of habitats would be excluded from the site. Darters, suckers and madtoms were not present since they require clear clean riffles, and centrarchids and black basses were absent because there was no pool habitat. Further downstream pool habitat was present but was considerably disjunct from the location sampled. The major contributor of poor conditions has to be traced to the high degree of urbanization surrounding the basin. Sewer overflows, point source dischargers, flow fluctuations, and salt runoff from street cleaning contribute greatly to the inability of this basin to achieve its potential. Habitat within the basin is adequate to support more species than what currently occurs.

The Chicago River and its supporting canal system have been modified so that their flow is away from Lake Michigan and into the Upper Illinois River. This was done to protect the City of Chicago's water supply from contamination and send waste products down the Illinois River. Better treatment processes and increased water quality regulation have reduced the amount of waste going to the system, thereby, having a dramatic effect on the Upper Illinois River mainstem. However, the station at Touhy Avenue on the North Branch Chicago River indicates that other urban affects have reduced the biological integrity of the water. Straightening of the River channel by channelization, runoff of road salts used for winter, and severe bank erosion have all but eliminated use of the River for aquatic life. Although the presence of luxuriant aquatic macrophyte beds, debris piles, and firm substrates should attract fish species, no fish were collected after extensive sampling at Touhy Avenue.

Overall, the Kankakee River sub-basin possessed the best water quality among Upper Illinois River sub-basins. Channelization of the River within Indiana has improved flow rates and increased flushing rates into Illinois. Water quality at Momence was observed to possess a "good" rating with an abundance of intolerant species, including: three species of darters, rock bass, various redhorse and sucker species, and cyprinids. The River at Momence has a shallow wide topography with some islands and vegetation along the stream margins. A nice selection of habitat diversity occurs within the area, however, no pool habitat was located during collection. Additional predators, such as northern pike, smallmouth and largemouth bass would have been located if these pools existed further improving the location score. At Shelby, the Kankakee River although still of good water quality had a reduction in IBI rating because of the

effect of channelization. The lack of shallow shore margins, the preponderance of sand substrate, and lack of heterogenous habitat has precluded many fish species from using the area. The lack of darter species and catfish were probably the most noticeable absent species.

Overall scoring indicated that the Kankakee River, followed by the Fox River, were the two best sub-basins in the Upper Illinois River System, while the DuPage, Des Plaines, and Chicago Rivers were respectively the next best. This presents an interesting comparison since the primary land use within the Kankakee and Fox River sub-basins include agricultural and less-concentrated residential uses, while the DuPage, Des Plaines, and Chicago River sub-basins are heavily populated urban and industrial areas. A distinct difference between the non-continuous non-point source of diffuse pollution compared to constant discrete point source input suggests that the water quality in these five sub-basins suffer from upstream inputs from the City of Chicago and industrial suburbs. The riparian buffer zone and amount of allochthonous input shows that a increase in degradation is apparent as one gets closer to the metropolitan areas of Chicago. Increases in bank stabilization, improvement in combined sewer overflow and road runoff, and other non-point source influences will greatly improve the resiliency of these Rivers.

Similar results were observed between streams of equal size, third order streams, e.g. Honey Creek, East Branch DuPage River, and Salt Creek, were all considered "poor" by IBI standards. However, Indian Creek and the North Branch Chicago River were outliers representing the best and worst case scenarios for the same order streams.

Acknowledgments

This report was prepared under contract with the U.S. Geological

Survey, Raleigh, North Carolina district. The sampling techniques described were those conducted by the U.S. Environmental Protection Agency, Region V, Central Regional Laboratory. Special thanks to Donald Krichiver, Charles S. Steiner, Max A. Anderson, and Pete Howe, U.S. Environmental Protection Agency, Region V, Chicago, Illinois, and Pete Ruhl, U.S. Geological Survey, Urbana, Illinois for their sampling assistance.

Literature Cited

Angermeier, P.L. and J.R. Karr. 1986. Applying an index of biotic integrity based on stream fish communities: considerations in sampling and interpretation. North American Journal of Fisheries Management 6. In press

Fausch, K.D., J.R. Karr, and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream-fish communities. Transactions of the American Fisheries Society 113:39-55.

Illinois Environmental Protection Agency (IEPA). 1988. Users guide to IBI-AIBI - version 2.01 (A Basic program for computing the Index of Biotic Integrity within the IBM-PC). State of Illinois Environmental Protection Agency, Division of Water Pollution and Planning Section, Marion, IL. IEPA/WPC/89-007.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6:21-27.

Karr, J.R., P.R. Yant, and K.D. Fausch. 1987. Spatial and temporal variability of the index of biotic integrity in three midwestern streams. Transactions of the American Fisheries Society 116(1):1-11.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters a method and its rationale. Illinois Natural History Survey Special Publ. 5, 28 pp.

Mills, H.B., W.C. Starrett, and F.C. Bellrose. 1966. Man's effect on the fish and wildlife of the Illinois River. Illinois Natural History Survey Biological Notes No. 57.

Ohio Environmental Protection Agency. 1987. Water quality implementation manual. QA Manual (3rd update) Fish. Ohio Environmental Protection Agency. Columbus, Ohio.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Annuals Association of American Geography. in press.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R. Hughs. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates. US Environmental Protection Agency, Monitoring and Data Support Division, Washington, D.C.

Steffeck, D. and R. Striegel. 1988. Macrobiological investigations that relate to stream water quality in the Upper Illinois River Basin. Unpublished report. U.S. Fish and Wildlife Service, Bloomington, IN.

U.S. Environmental Protection Agency. 1988. Standard Operating Procedure for conducting rapid assessment of ambient water quality conditions using fish. USEPA, Region V, Central Regional Laboratory, Chicago, IL.

U.S. Environmental Protection Agency. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Water and Effluents. Environmental Monitoring and Support laboratory- Cincinnati, OH. EPA 670/4-73-001.

Upper Illinois River Water Quality

Appendix A. Fish metrics used to score specimens collected from the Sub-basins of the Upper Illinois River during July and August, 1989.

Species	Native	Endangered	Tolerance	Feeding Guild	Habitat Preference		
					S	C	R
Gizzard shad	N			Omni	X		X
Alewife	I						X
Skipjack herring	N			Carn	X		X
Northern pike	N			Carn	X		X
Grass pickerel	N			Carn	X	X	
Carp	I		Tolerant	Omni	X	X	X
Goldfish	I		Tolerant	Omni		X	X
Common stoneroller	N			Herb	X	X	
Rosyface shiner	N		Intolerant	Insect	X	X	
Emerald shiner	N			Insect	X		X
River shiner	N			Insect			X
Mimic shiner	N		Intolerant	Omni	X	X	X
Sand shiner	N			Insect	X	X	
Bigmouth shiner	N			Omni	X	X	
Spottail shiner	N			Insect	X		X
Spotfin shiner	N		Intolerant	Insect	X	X	X
Common shiner	N			Insect	X	X	
Golden shiner	N			Omni	X		X
Bluntnose minnow	N			Omni	X	X	X
Fathead minnow	N			Omni	X	X	X
Bullhead minnow	N		Intolerant	Omni	X		X
Suckermouth minnow	N			Insect	X		X
Creek chub	N			Insect	X	X	X
Hornyhead chub	N			Insect	X	X	X
White sucker	N				X	X	X
Shorthead redhorse	N		Intolerant		X		X
Silver redhorse	N		Intolerant		X		X
Quillback	N			Omni	X		X
Smallmouth buffalo	N				X		X
Spotted sucker	N						X
Northern hogsucker	N		Intolerant		X	X	X
Brook silverside	N				X	X	X
Blackstripe topminnow	N				X	X	X
Flathead catfish	N			Carn			X
Channel catfish	N			Carn			X
Yellow bullhead	N				X		X
Black bullhead	N				X		X
Tadpole madtom	N				X	X	
Stonecat	N		Intolerant		X	X	X
White bass	N			Carn			X
Yellow bass	N			Carn			X
Rock bass	N		Intolerant	Carn	X	X	X
Largemouth bass	N			Carn	X	X	X
Smallmouth bass	N		Intolerant	Carn	X	X	X
Bluegill	N				X		X
Green sunfish	N		Tolerant		X	X	X

Appendix A (continued)

Longear sunfish	N	Intolerant	X	X
Pumpkinseed	N		X	X
Orangespotted sunfish	N		X	X
White crappie	N	Carn	X	X
Black crappie	N	Carn	X	X
Yellow perch	N	Carn	X	X
Johnny darter	N		X	X X
Rainbow darter	N	Intolerant	X	X
Fantail darter	N	Intolerant	X	X
Banded darter	N	Intolerant	X	X
Blackside darter	N		X	X X
Logperch	N		X	X X
Slenderhead darter	N	Intolerant	X	X
Freshwater drum	N		X	X
Mottled sculpin	N	Intolerant	X	X

S - Streams and smaller rivers

C - Creeks and brooks

R - Larger rivers

Omni - Omnivore

Insect - Insectivorous cyprinid

Carn - Carnivore